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### REMARKS

Entry of this Amendment is proper because it does not raise new issues and does not require further search by the Examiner.

Claims 8, 15, 23-32, and 34-39 and 42-46 are all the claims presently pending in the application. Claims 8, 15, 23 and 30 have been amended to more particularly define the invention. Claim 41 has been canceled.

It is noted that the claim amendments are made only for more particularly pointing out the invention, and not for distinguishing the invention over the prior art, narrowing the claims or for any statutory requirements of patentability. Further, Applicant specifically states that no amendment to any claim herein should be construed as a disclaimer of any interest in or right to an equivalent of any element or feature of the amended claim.

Claims 8, 15, 23-29 and 41-46 stand rejected under 35 U.S.C. § 112, first paragraph as allegedly including subject matter not disclosed in the specification. Claims 8, 15, 23-25, 27, 29-32, 34-36, 38-39, 41-42 and 45-46 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Zheng, et al. (U.S. Patent No. 5,728,621), in view of Liao (U.S. Patent No. 6,110,795). Claims 26, 28 and 37 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Zheng, et al. (U.S. Patent No. 5,728,621), in view of Liao (U.S. Patent No. 6,110,795), and further in view of Kunikiyo (U.S. Patent No. 6,620,703). Claims 43-44 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Zheng, et al. (U.S. Patent No. 5,728,621), in view of Liao (U.S. Patent No. 6,110,795), and further in view of Brewer (U.S. Patent No. 6,332,600).

These rejections are respectfully traversed in the following discussion.

#### **I. THE CLAIMED INVENTION**

The claimed invention (e.g., as recited in claim 1 and similarly recited in claims 15 and 23) is directed to a semiconductor substrate having a trench region comprising at least one trench, the trench comprising a single layer of high-density plasma (HDP) oxide having an

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unpolished upper surface, and a non-trench region having an upper surface which is substantially co-planar with the unpolished upper surface of the single layer of the HDP oxide, the upper surface of the non-trench region including implanted dopants.

Importantly, the upper surface of the HDP oxide includes a slightly-etched surface, such that a thickness of the single layer of HDP oxide includes an originally-deposited thickness of the oxide less an amount of the oxide removed by a slight etch.

Conventional substrates having shallow trench isolation (STI) regions require harsh etching or chemical mechanical polishing (CMP) to planarize the surface of the substrate and filler material formed in trenches in the substrate. As a result the surface of the trench fill material includes scratches and chatter marks.

In the claimed substrate, on the other hand, the upper surface of the HDP oxide includes a slightly-etched surface, such that a thickness of the single layer of HDP oxide includes an originally-deposited thickness of the oxide less an amount of the oxide removed by a slight etch. (Application at page 7, line 20-page 8, line 9; Figure 2). By forming the upper surface of the HDP oxide to have a slightly-etched surface, a tight seal can be formed (e.g., around the HDP oxide filler material) during formation of the substrate. This tight seal helps to ensure that the HDP oxide within the trench will not be inadvertently etched when the HDP oxide material outside of the trench (e.g., in a non-trench region) is etched away. This allows the claimed substrate to have a HDP oxide trench fill with a substantially scratch free and substantially uniform upper surface.

## II. THE 35 USC §112, FIRST PARAGRAPH REJECTION

The Examiner alleges that claims 8, 15, 23-29 and 41-46 include subject matter not disclosed in the specification. Applicant submits, however, that these claims are clearly disclosed in the specification and clearly enabled.

Specifically, the Examiner alleges that the term "slightly-etched surface" is not disclosed in the specification. The Examiner concedes that the specification discloses this feature at page

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7, but the Examiner alleges that the “slightly-etched surface disclosed at page 7 of the specification is “an intermediate structure, not a final, planar structure”. The Examiner is clearly confused.

In fact, the Examiner appears to entirely miss an important point of the claimed invention which is emphasized repeatedly in the specification. Namely, an object of the claimed invention is provide a planarized shallow trench isolation (STI) structure which is formed **without requiring the use of steps such as Reactive Ion Etching (RIE), etch back or chemical mechanical polishing (CMP)** (Application at page 12, lines 17-18). Such an STI structure may be formed, for example, by depositing a layer of high density plasma (HDP) oxide in the trench and non-trench regions (Application at Figure 1), and etching the oxide slightly in order to remove the oxide 50c at the upper edge of the trench and expose the pad nitride 40 (Application at Figure 2). The photoresist 60 is then formed over the trench region 20 (Application at Figure 3), the exposed oxide 50a is etched away (Application at Figure 4), and the photoresist 60 is removed (Application at Figure 5). The pad nitride 40 is removed (Application at Figure 6) and the pad oxide 30 is removed to provide the planarized structure illustrated in Figure 7 of the Application.

That is, contrary to the Examiner’s allegations, the “slightly-etched surface” is not an “intermediate structure”, but instead may be included in HDP oxide in the trench region of the claimed invention. Indeed, the Application expressly provides that **“the nitride pad 40 and oxide pad 30 are removed resulting in the planarized STI”** (emphasis added) (Application at page 11, lines 2-3). That is, in the claimed invention, the oxide deposited in the trench needs only to be “slightly-etched” in order to be substantially co-planar with the non-trench region. Unlike convention substrates, in the claimed invention there is no need for RIE, etch back or CMP to provide a planarized STI structure.

The Examiner further states that “there is not sufficient description to define the metes and bounds of “etched slightly”. The Examiner is clearly incorrect.

Indeed, Applicant would remind the Examiner that 35 USC 112, first paragraph requires

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only that the claimed invention be described with sufficient clarity for one of ordinary skill in the art to make and use the invention. Clearly, one of ordinary skill in the art could read the invention and instantly understand the meaning of the term "slightly-etched".

Again, Applicant would point out that the Application states that the HDP oxide is "slightly-etched" to remove the oxide 50c. It is further stated that the thickness of the oxide 50c is "on the order of the nitride film 40 or thinner" (Application at page 6, lines 10-11). It is further stated that the pad nitride 40 is "a buffer film to protect the raised regions of the silicon ... during the trench isolation fabrication process" (Application at page 9, line 19-page 10, line 1). Thus, it may be considered that by "slightly etched", the thickness of the oxide is reduced by no more than the thickness of the pad nitride 40, which is easily understood and could likely be easily put to practice by one of ordinary skill in the art.

In fact, Applicant would point out to the Examiner that the Zheng reference (on which the Examiner relies) teaches that a thickness of a pad nitride layer should be between about 500 Å and 2000 Å (Zheng at col. 2, lines 29-32). Therefore, **the thickness of the oxide 50c would likely be known to one of ordinary skill in the art, and thus, the amount of oxide 50b in the trench region which is removed by the "slight etch" would likely be known to one of ordinary skill in the art.**

Thus, Applicant respectfully submits that one of ordinary skill in the art could easily read the specification and be able to make and use the claimed invention. Thus, Applicant respectfully submits that the term "slightly-etched" is clearly enabled by the specification.

In view of the foregoing, the Examiner is respectfully requested to withdraw this rejection.

### III. THE PRIOR ART REFERENCES

#### A. The Zheng and Liao References

The Examiner alleges that Zheng would have been combined with Liao to form the claimed invention of claims 8, 15, 23-25, 27, 29-32, 34-36, 38-39 and 41-42. Applicant submits,

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however, that these references would not have been combined and even if combined, the combination would not teach or suggest each and every element of the claimed invention.

Zheng discloses a method for forming planarized oxide shallow trench isolation. In the Zheng method, a high density plasma (HDP) oxide layer is deposited in the isolation trenches. A layer of spin-on-glass is coated over the HDP oxide layer. The spin-on-glass layer and portions of the HDP oxide layer remaining are polished away so that the substrate is planarized (Zheng at Abstract).

Liao discloses a method of correcting the scratches caused by CMP. In the Liao method, a microscratch formed in an isolation trench caused by chemical mechanical polishing is corrected by forming a sacrificial layer on the damaged trench fill so that the micro-scratch is thus filled with the sacrificial layer. Using a hard mask as an etch stop, the sacrificial layer is etched back. Since the etching rate of the sacrificial layer is the same as or lower than the isolation trench material, the formation of the micro-scratch is suppressed during the etching back process (Liao at Abstract).

However, Applicant submits that these references would not have been combined as alleged by the Examiner. Indeed, these references are directed to different problems. Specifically, Zheng planarizes a substrate surface by chemical mechanical polishing (CMP), whereas Liao teaches a method of correcting the damage (e.g., microscratches) caused by CMP (Liao at col. 1, lines 13-17). Indeed, Zheng does not even recognize the surface damage (e.g., scratches, chatter marks) caused by CMP and, unlike Liao, does not take any action to correct the damage. Therefore, Liao specifically teaches that the Zheng device is defective. Clearly, these references teach away from each other so that no person of ordinary skill in the art would have considered combining the references.

Further, Applicant submits that the Examiner can point to no motivation or suggestion in the references to urge the combination as alleged by the Examiner. Indeed, the references do not include such a suggestion as alleged by the Examiner. Therefore, Applicant respectfully submits that one of ordinary skill in the art would not have been so motivated to combine the references

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as alleged by the Examiner. Therefore, the Examiner has failed to make a prima facie case of obviousness.

Moreover, contrary to the Examiner's allegations, neither Zheng nor Liao nor any combination thereof, teaches or suggests *"wherein said upper surface of said HDP oxide comprises a slightly-etched surface, such that a thickness of said single layer of HDP oxide comprises an originally-deposited thickness of said oxide less an amount of said oxide removed by a slight etch"*, as recited, for example, in claims 8, 15 and 23.

As noted above, by forming the upper surface of the HDP oxide to have a slightly-etched surface, a tight seal can be formed (e.g., around the HDP oxide filler material) during formation of the substrate. This tight seal helps to ensure that the HDP oxide within the trench will not be inadvertently etched when the HDP oxide material outside of the trench (e.g., in a non-trench region) is etched away. This allows the claimed substrate to have a HDP oxide trench fill with a substantially scratch free and substantially uniform upper surface.

Clearly, the cited references do not teach or suggest these novel features. Indeed, **both Zheng and Liao teach an STI structure formed by both etch back and chemical mechanical polishing, which cause the problems of conventional structures which the exemplary aspects of the claimed invention intends to avoid.**

Further, the Examiner surprisingly alleges that page 8 of the specification "teaches that an etch is beneficial, but not necessary". The Examiner has clearly misread the specification.

In fact, the portion of the Application to which the Examiner refers states that "[a]n etch process **that is largely isotropic** is beneficial, but etch isotropy is not a necessary feature". (emphasis added) (Application at page 8, lines 17-18). That is, the Application does not state that the "slight etch" is not necessary, but only that an isotropic characteristic of the etch is not necessary.

In fact, the Application makes clear that the "slightly-etched surface" is very important. Specifically, the slight etch exposes the pad nitride 40 so that a tight seal can be provided at the upper edges of the isolation trench. This allows the oxide 50a in the non-trench region to be

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etched away without damaging the oxide 50b in the trench. Indeed, the Application expressly states that “[c]reating and maintaining a tight seal at these interfaces is important” (Application at page 9). Thus, the Application implies that the “slightly-etched surface” is important to the claimed invention. Therefore, the Examiner is clearly incorrect.

The Examiner surprisingly alleges that Zheng “masks the oxide fill prior to etching and the fill of figure 10 is substantially the same as the as-deposited fill of figure 8” (Office Action at page 8). However, the Examiner is again incorrect.

Zheng teaches that the oxide is deposited to a thickness of about 10,000Å (Zheng at col. 2, lines 43-45; Figure 3) and about 8,000Å of spin-on-glass is deposited on the oxide (Zheng at Figure 4; col. 3, lines 10-12). Thus, Zheng does not teach or suggest masking the oxide fill as alleged by the Examiner. Then, Zheng etches the structure until about 3000Å of oxide is left on the silicon nitride 14 (Zheng at Figure 5), and the structure is polished using CMP to planarize the structure (Zheng at Figure 6).

Thus, Zheng teaches that the originally-deposited thickness of the oxide is 10,000Å and the oxide is etched and polished until the thickness is about 2000Å (i.e., the depth of the trench). Thus, in complete contrast to the claimed invention, Zheng does not teach or suggest an upper surface of HDP oxide which includes a slightly-etched surface, such that a thickness of the HDP oxide includes an originally-deposited thickness of the oxide less an amount of the oxide removed by a slight etch. Instead, **Zheng teaches that the oxide should have a significantly etched surface so that the thickness of the oxide (e.g., about 2000Å) is much less than the originally-deposited thickness (e.g., about 10,000Å).** Moreover, Zheng goes on to teach that the corners of the oxide 18 are further etched to provide rounded corners. Thus, Zheng is completely unrelated to the claimed invention.

Similarly, Liao does not teach or suggest these novel features. Specifically, Liao clearly does not teach or suggest an HDP oxide in a trench region (e.g., in the trench) having a “slightly-etched surface”. Indeed, like Zheng, Liao teaches that an oxide fill is significantly etched during an etch back process (Liao at Abstract; Figure 2E). Further, Liao certainly does not teach or

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suggest a single layer of HDP oxide having a thickness which includes an originally-deposited thickness of the oxide less an amount of the oxide removed by a slight etch. Thus, Liao clearly does not make up for the deficiencies of Zheng.

Therefore, Applicant submits that these references would not have been combined and even if combined, the combination would not teach or suggest each and every element of the claimed invention. Therefore, the Examiner is respectfully requested to withdraw this rejection.

#### **B. The Kunikiyo Reference**

The Examiner alleges that Zheng would have been combined with Laio, and the alleged Zheng/Laio combination would have been further combined with Kunikiyo to form the claimed invention of claims 26, 28 and 37. Applicant submits, however, that these references would not have been combined and even if combined, the combination would not teach or suggest each and every element of the claimed invention.

Kunikiyo discloses a device having isolation characteristics of an isolation trench which are allegedly enhanced. In the device, elements to be isolated by an isolation trench (STI 2) are formed in active semiconductor regions shown by arrows 30 and 31 on a semiconductor substrate 1. The STI 2 is filled with SiOF (Kunikiyo at Abstract; Figure 1).

However, Applicant submits that these references would not have been combined as alleged by the Examiner. Indeed, Zheng and Liao are directed to planarizing isolation regions, whereas Kunikiyo which is intended to improve the isolation characteristics of a isolation trench by using SiOF as a filler material. Clearly, these references are unrelated and no person of ordinary skill in the art would have considered combining the references.

Further, Applicant submits that the Examiner can point to no motivation or suggestion in the references to urge the combination. Indeed, Applicant respectfully submits that one of ordinary skill in the art would not have been so motivated to combine the references as alleged by the Examiner. Therefore, the Examiner has failed to make a prima facie case of obviousness.

Moreover, contrary to the Examiner's allegations, neither Zheng nor Liao, nor Kunikiyo,



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nor any combination thereof, teaches or suggests "*wherein said upper surface of said HDP oxide comprises a slightly-etched surface, such that a thickness of said single layer of HDP oxide comprises an originally-deposited thickness of said oxide less an amount of said oxide removed by a slight etch*", as recited, for example, in claims 8, 15 and 23.

As noted above, by forming the upper surface of the HDP oxide to have a slightly-etched surface, a tight seal can be formed (e.g., around the HDP oxide filler material) during formation of the substrate. This tight seal helps to ensure that the HDP oxide within the trench will not be inadvertently etched when the HDP oxide material outside of the trench (e.g., in a non-trench region) is etched away. This allows the claimed substrate to have a HDP oxide trench fill with a substantially scratch free and substantially uniform upper surface.

Clearly, the cited references do not teach or suggest these novel features. Indeed, the Examiner merely relies on Kunikiyo as allegedly teaching a fluorine-doped high density plasma oxide. That is, the Examiner does not allege that Kunikiyo does not teach or suggest an upper surface of said HDP oxide including a slightly-etched surface, such that a thickness of a single layer of HDP oxide includes an originally-deposited thickness of the oxide less an amount of the oxide removed by a slight etch, as in the claimed invention.

In fact, Kunikiyo merely teaches that the SiOF film 40 is "flattened" by CMP (Kunikiyo at Figure 4; col. 11, lines 55-59). That is, nowhere does Kunikiyo teach or suggest an HDP oxide (e.g., in a trench region ) having an upper surface which includes a slightly-etched surface. Thus, Kunikiyo clearly does not make up for the deficiencies of the alleged Zheng/Liao combination.

Therefore, Applicant submits that these references would not have been combined and even if combined, the combination would not teach or suggest each and every element of the claimed invention. Therefore, the Examiner is respectfully requested to withdraw this rejection.

### C. The Brewer Reference

The Examiner alleges that Zheng would have been combined with Laio, and the alleged

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Zheng/Laio combination would have been further combined with Brewer to form the claimed invention of claims 43-44. Applicant submits, however, that these references would not have been combined and even if combined, the combination would not teach or suggest each and every element of the claimed invention.

Brewer discloses a planarization composition for CMP of dielectric layers (Brewer at Abstract).

However, Applicant submits that these references would not have been combined as alleged by the Examiner. Indeed, Zheng and Liao are directed to planarizing isolation regions, whereas Brewer is merely directed to a composition for CMP. Clearly, these references are unrelated and no person of ordinary skill in the art would have considered combining the references.

Further, Applicant submits that the Examiner can point to no motivation or suggestion in the references to urge the combination. Indeed, Applicant respectfully submits that one of ordinary skill in the art would not have been so motivated to combine the references as alleged by the Examiner. Therefore, the Examiner has failed to make a prima facie case of obviousness.

Moreover, contrary to the Examiner's allegations, neither Zheng nor Liao, nor Brewer, nor any combination thereof, teaches or suggests "*wherein said upper surface of said HDP oxide comprises a slightly-etched surface, such that a thickness of said single layer of HDP oxide comprises a substantially as-deposited thickness*" as recited, for example, in claims 8, 15 and 23.

Clearly, these novel features are not taught or suggested by Brewer. Indeed, the Examiner is merely relying on Brewer as allegedly disclosing phosphorus-doped or boron-doped oxide.

Moreover, Applicant would respectfully point out that Brewer is directed to a composition for CMP. Applicant submits that it would be very unlikely for one of ordinary skill in the art to utilize Brewer which teaches a composition for CMP to form an invention having an express purpose of avoiding CMP. Thus, Brewer is completely unrelated to the claimed invention.

In fact, nowhere does Brewer teach or suggest an HDP oxide, let alone, an upper surface

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of said HDP oxide including a slightly-etched surface, such that a thickness of a single layer of HDP oxide includes an originally-deposited thickness of the oxide less an amount of the oxide removed by a slight etch, as in the claimed invention. Thus, Brewer fails to make up for the deficiencies of the alleged Zheng/Liao combination.

Therefore, Applicant submits that these references would not have been combined and even if combined, the combination would not teach or suggest each and every element of the claimed invention. Therefore, the Examiner is respectfully requested to withdraw this rejection.

### III. FORMAL MATTERS AND CONCLUSION

A Submission of Replacement Drawing Sheet for sheet number 3 of 7 (e.g., Figures 5-7) is filed concurrently herewith. Applicant notes that in the Replacement Drawing Sheet, Figure 6 has been corrected to illustrate the oxide layer 30, and to replace the designation "50a" with "50b". Applicant notes that these features in the Replacement Drawing Sheet are clearly disclosed in the Application (e.g., see Application at page 8, line 10-page 10, line 10).

In view of the foregoing, Applicant submits that claims 8, 15, 23-32, 34-39 and 41-46, all the claims presently pending in the application, are patentably distinct over the prior art of record and are in condition for allowance. The Examiner is respectfully requested to pass the above application to issue at the earliest possible time.

Should the Examiner find the application to be other than in condition for allowance, the Examiner is requested to contact the undersigned at the local telephone number listed below to discuss any other changes deemed necessary in a telephonic or personal interview.

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The Commissioner is hereby authorized to charge any deficiency in fees or to credit any overpayment in fees to Assignee's Deposit Account No. 09-0456.

Date: 12/30/04

Respectfully Submitted,



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**CERTIFICATE OF FACSIMILE TRANSMISSION**

I hereby certify that the foregoing Amendment was filed by facsimile with the United States Patent and Trademark Office, Examiner David Blum, Group Art Unit # 2813 at fax number (703) 872-9306 this 30th day of December, 2004.



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